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Jawidzik et al.

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(54) **CORD RETRACTOR**

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B65H 75/00 (2006.01)
B65H 75/48 (2006.01)

(52) **U.S. Cl.**
CPC ***B65H 75/486*** (2013.01)

(58) **Field of Classification Search**
CPC B65H 75/40; B65H 75/446; B65H 75/486; B60L 11/1816
See application file for complete search history.

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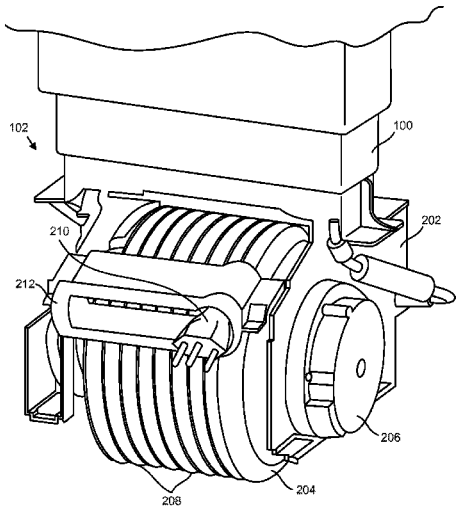
(57) **ABSTRACT**

A cord retractor includes a support member, a first length of electrical cord, a spool, and a second length of electrical cord. The spool includes a helical groove on an outer surface of the spool. The helical groove has a width corresponding to a cross-sectional width of the first length of electrical cord, and the spool is rotatably mounted on the support member. The second length of electrical cord is electrically coupled to the first length of electrical cord. A first portion of the second length of electrical cord is secured at a rotating location, and a second portion of the second length of electrical cord is secured at a stationary location. The first length of electrical cord is selectively extendable from and retractable on the spool, and the second cord flexes to accommodate the movement of the rotating location with respect to the stationary location.

26 Claims, 8 Drawing Sheets



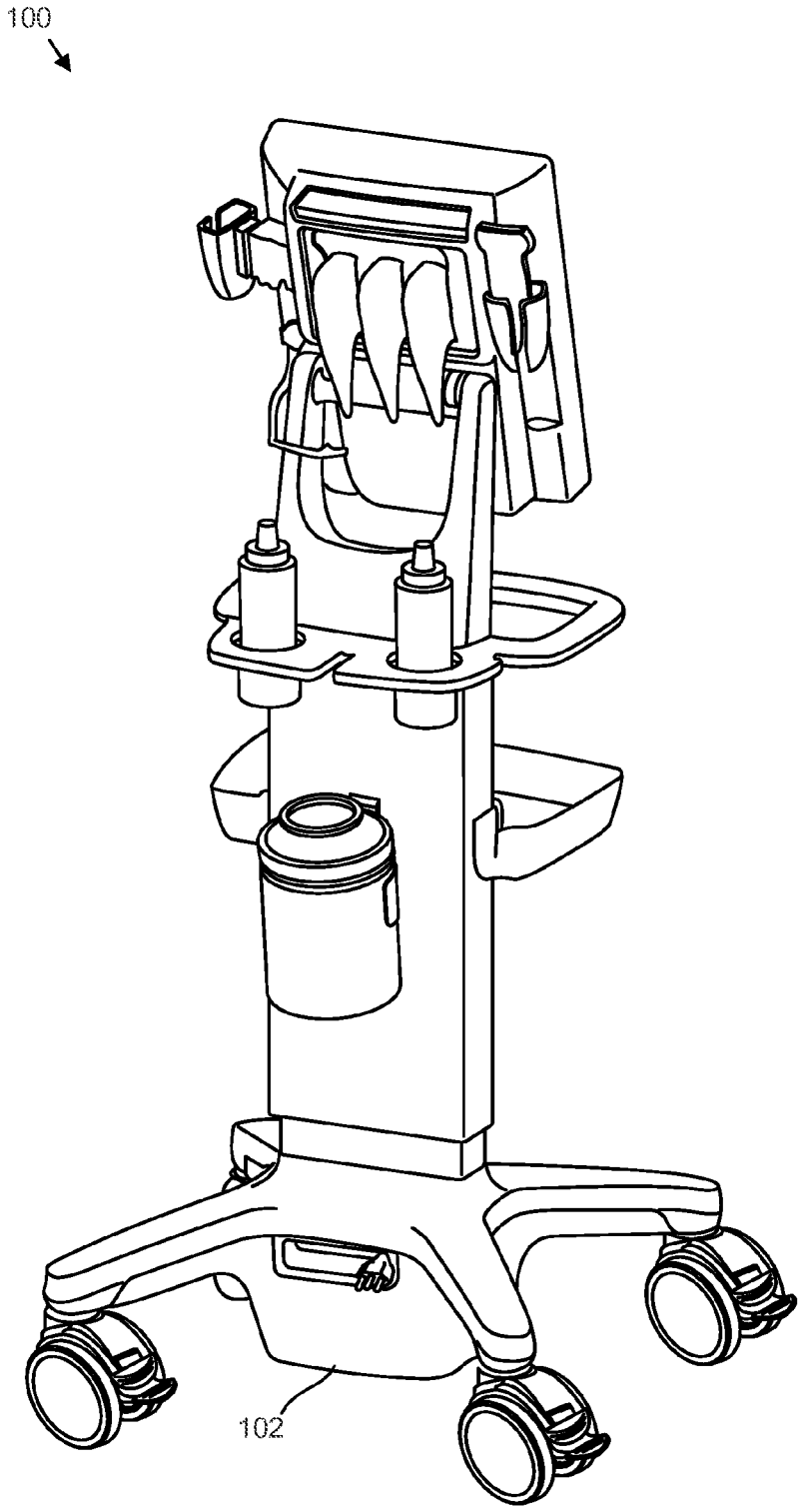


FIG. 1

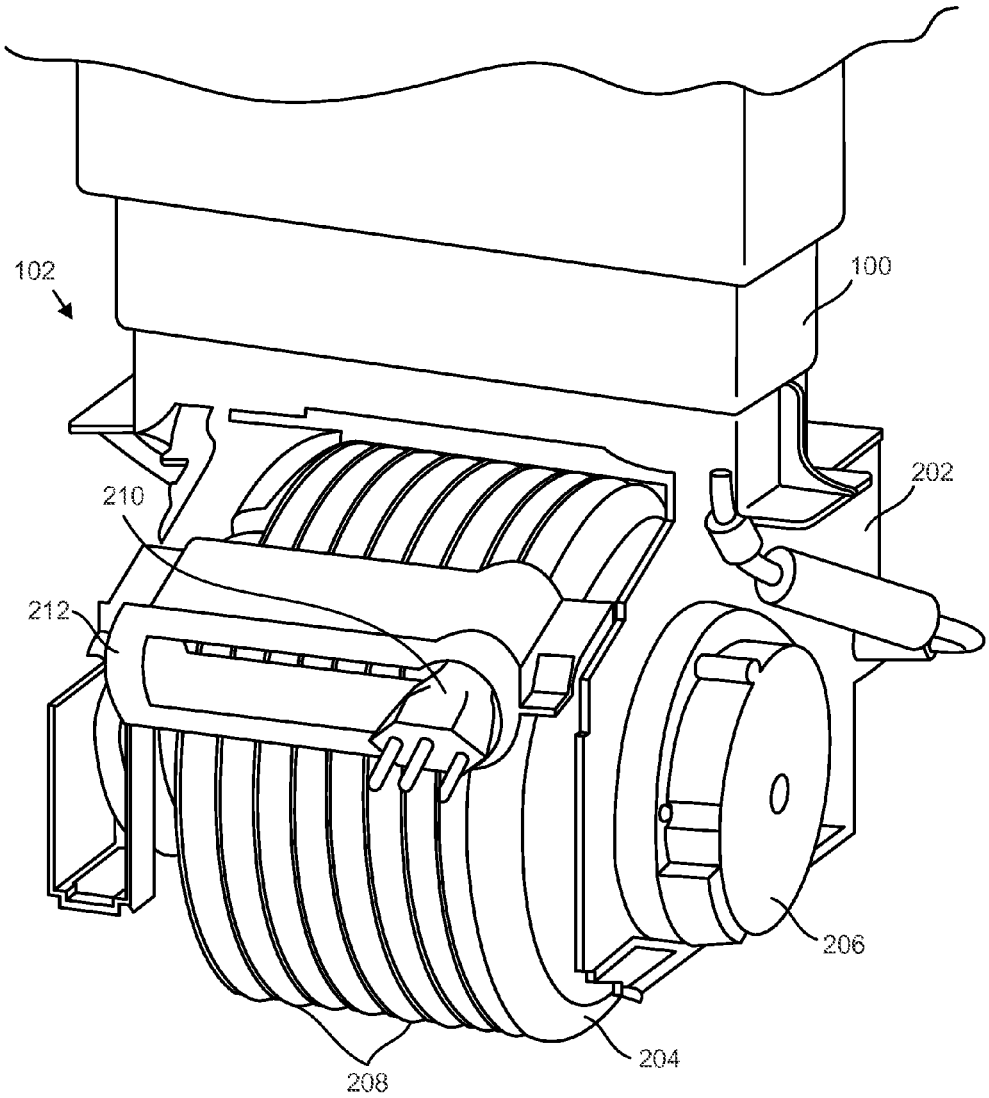


FIG. 2

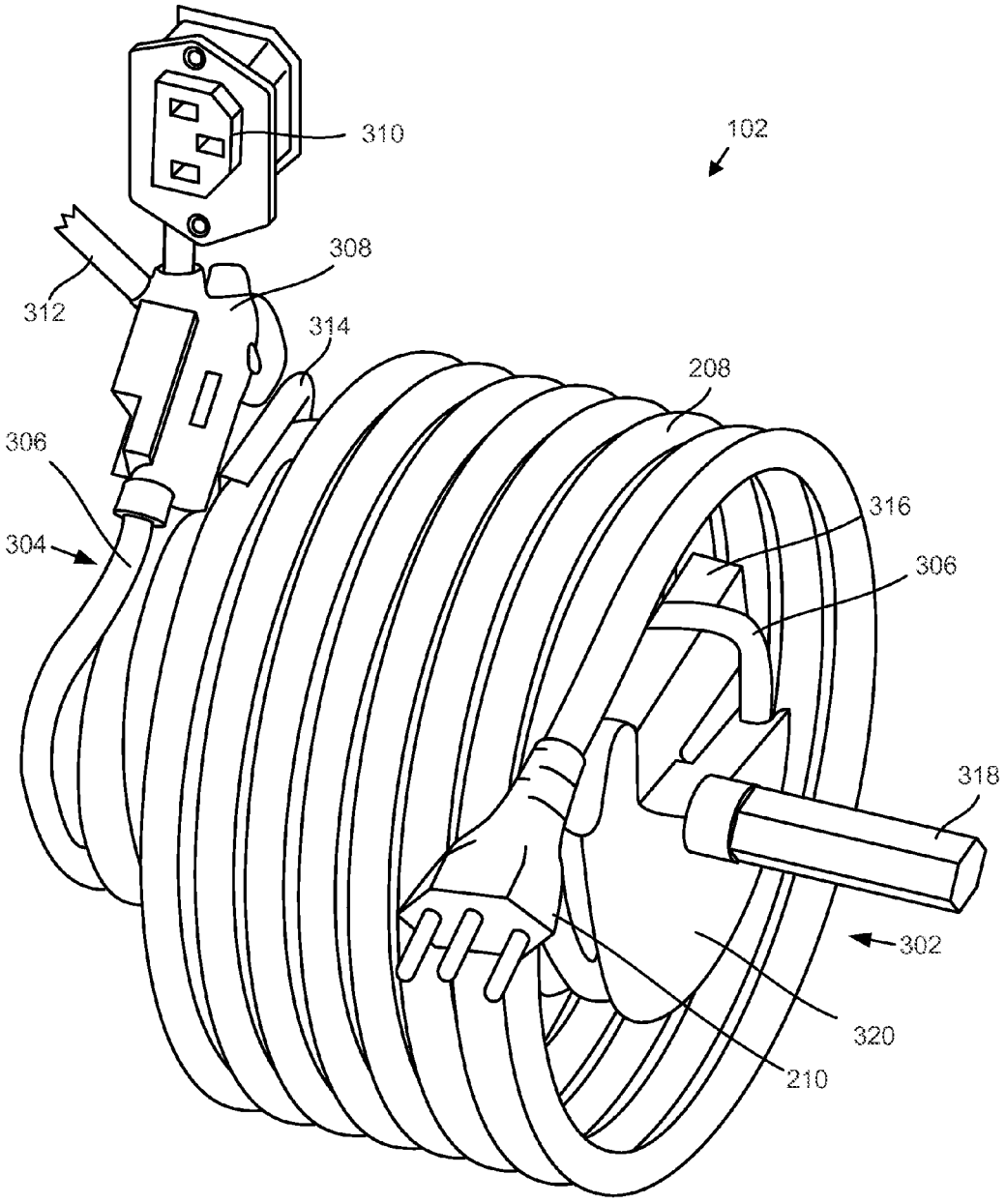


FIG. 3

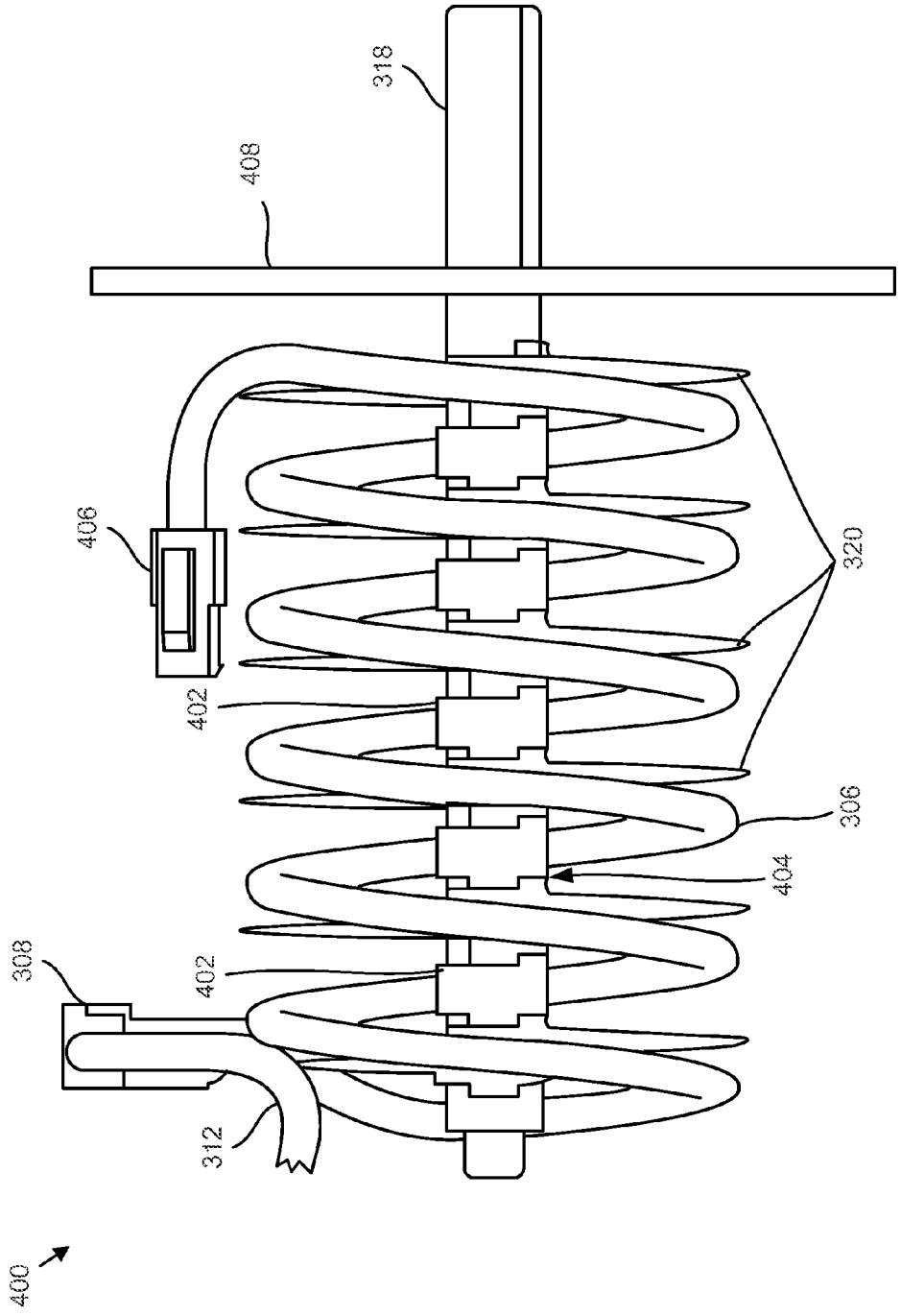


FIG. 4

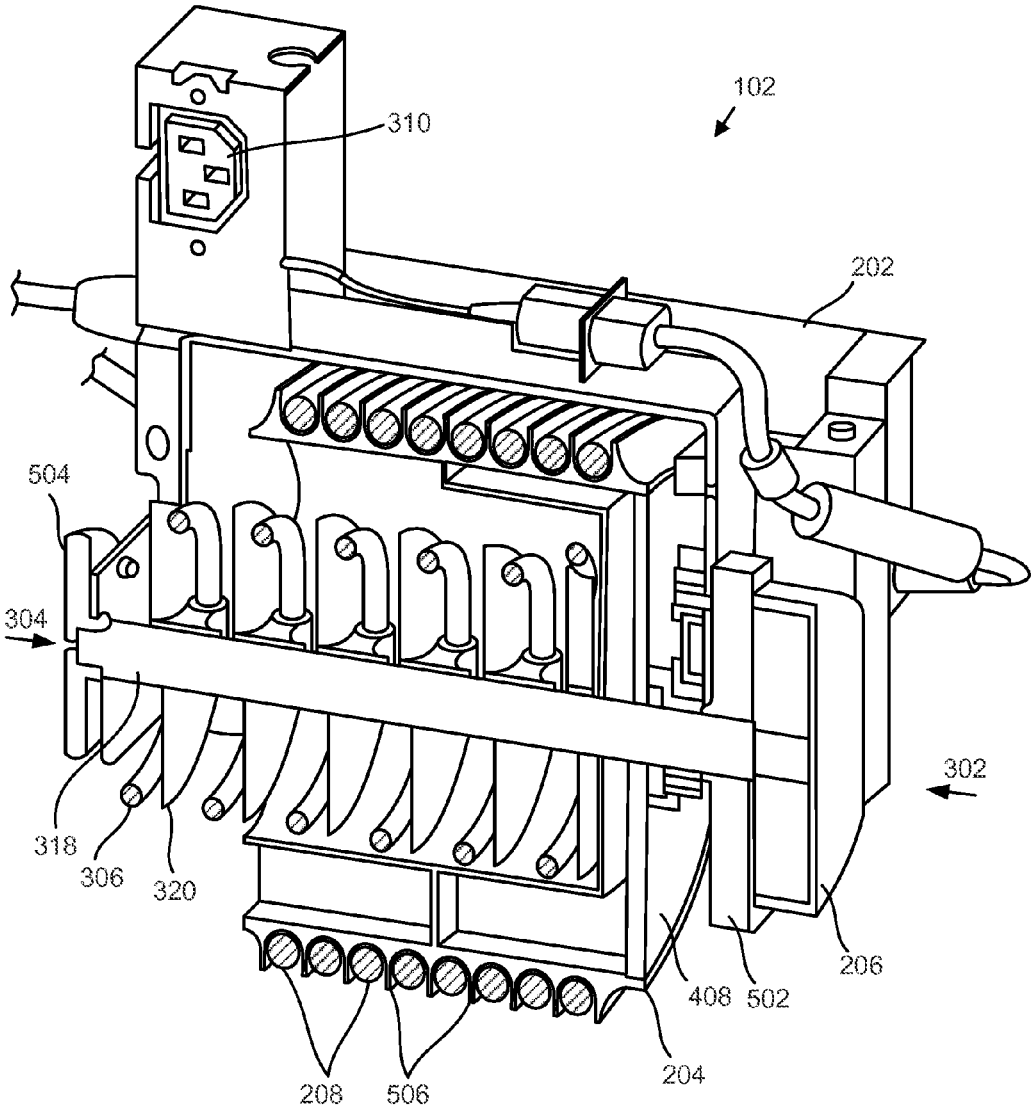


FIG. 5

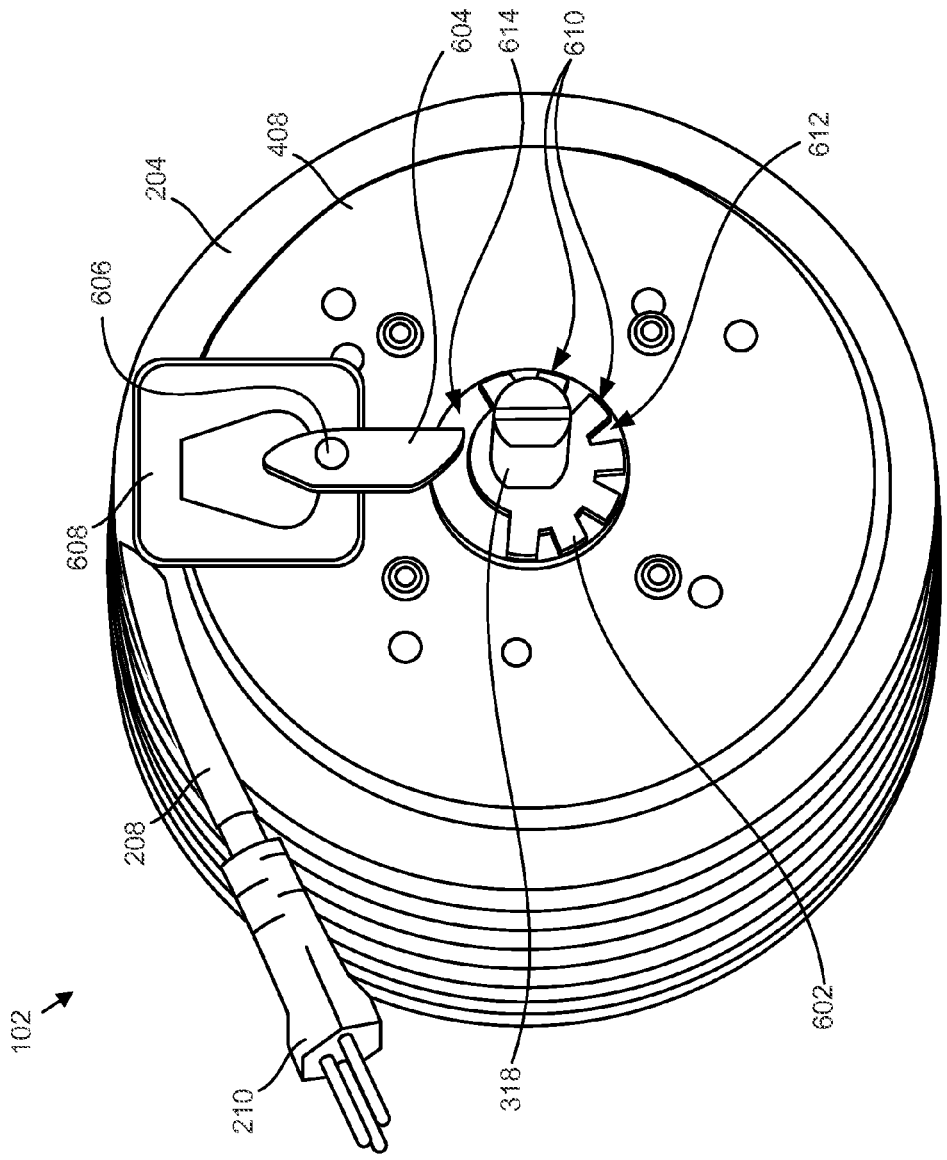


FIG. 6

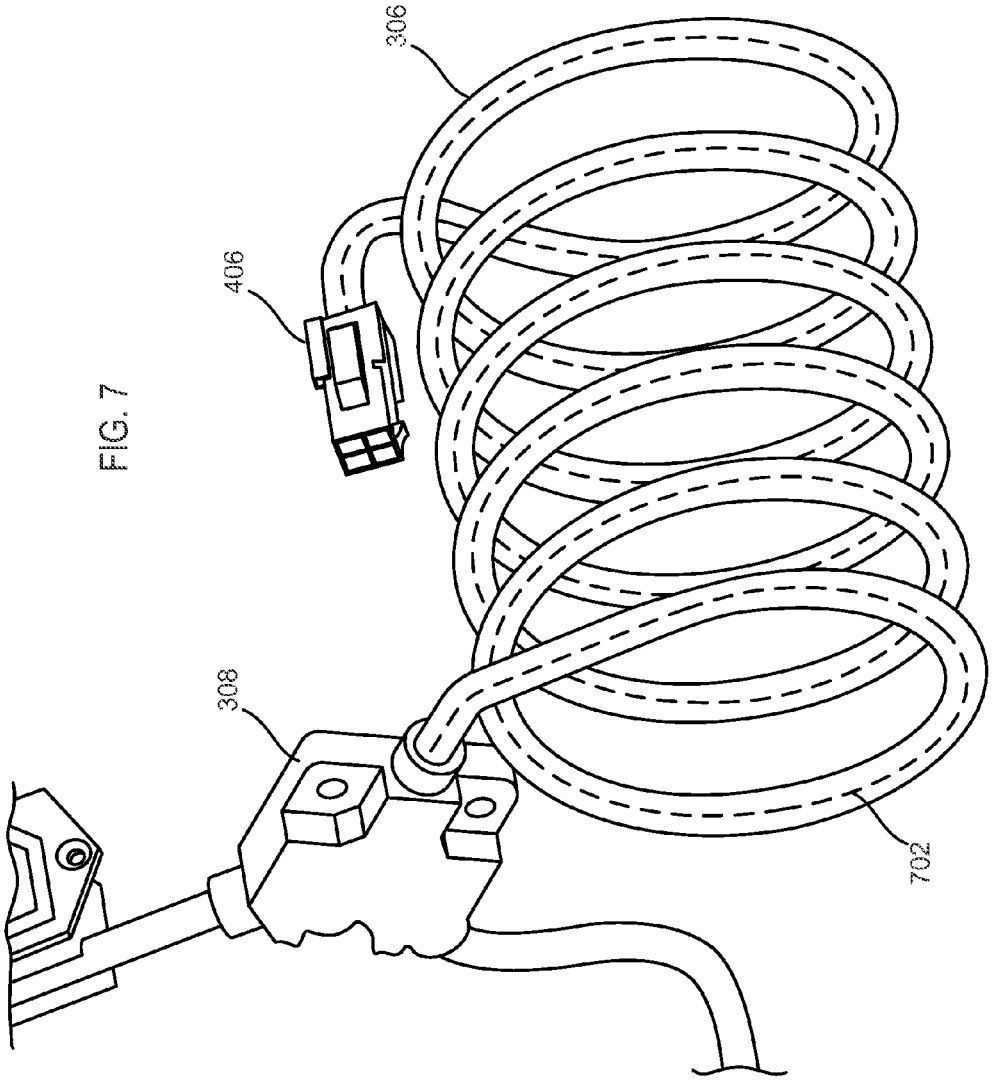


FIG. 7

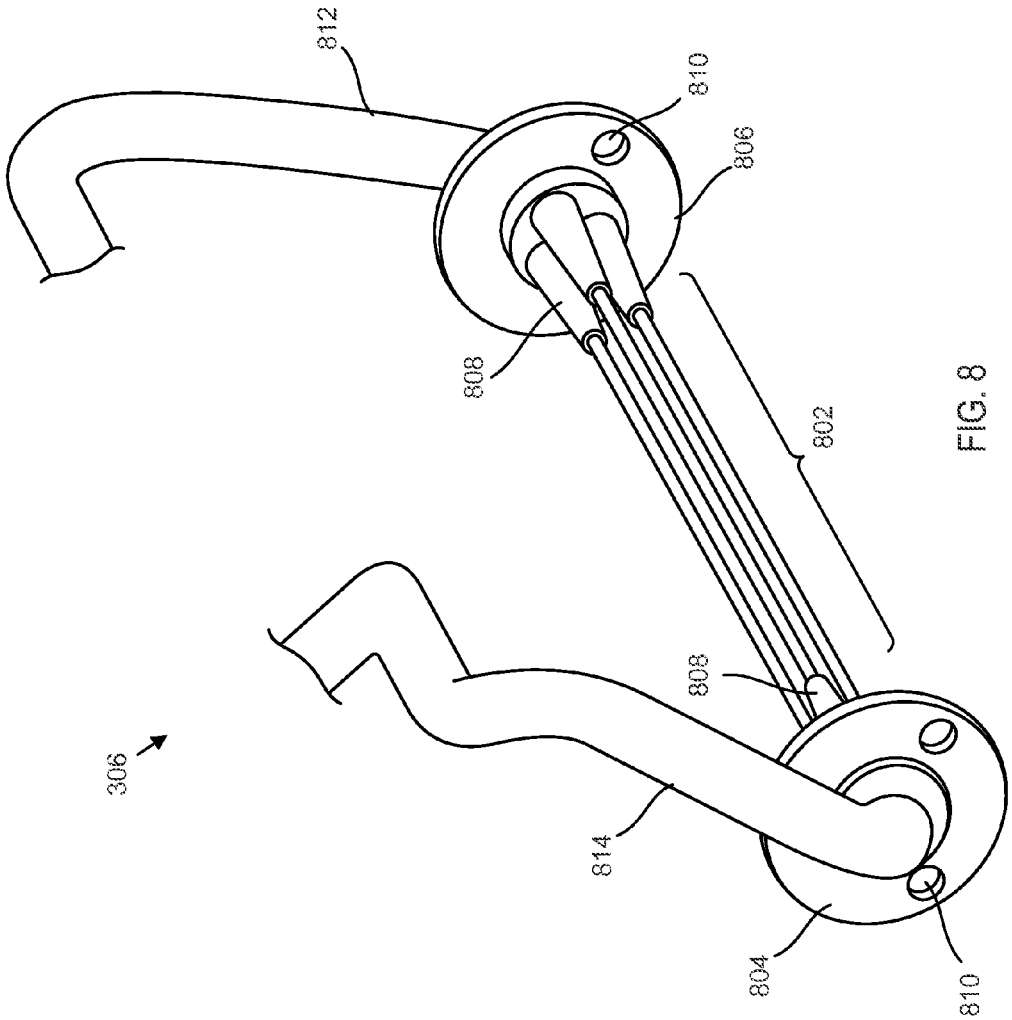


FIG. 8

CORD RETRACTOR

TECHNICAL FIELD

The present disclosure relates to power cords and power cord storage, and more particularly relates to cable retractors for power cords.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a perspective view of a medical device trolley having a cable retractor, according to one embodiment.

FIG. **2** is a perspective view of interior components of a cable retractor, according to one embodiment.

FIG. **3** is another perspective view of interior components of a cable retractor, according to one embodiment.

FIG. **4** is a perspective view of an interior cable assembly, according to one embodiment.

FIG. **5** is a cross-sectional side view of a cable retractor, according to one embodiment.

FIG. **6** is a perspective side view of a ratchet and pawl for a cable retractor, according to one embodiment.

FIG. **7** is a perspective view of an interior cable with a cable support, according to one embodiment.

FIG. **8** is a perspective view of an interior cable that includes one or more separate wire sections, according to one embodiment.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

Power cords are often used to conduct electrical power from an outlet to provide power to electrically powered devices. When such a device is relatively stationary, the power cord may be left connected between the outlet and the device and may be positioned or routed so as to be acceptably non-intrusive of normal activities of a user. However, when such a device is relatively mobile, the power cord is necessarily disconnected during transport, and may be wound onto a suitable feature or features of the device, to facilitate storage during transport.

In cases where transport is very frequent, mechanisms may be provided to automatically wind the power cord onto a suitable feature or features of the device. Such mechanisms commonly employ a cylindrical spool, an intermittently engaging ratchet, and sliding electrical contacts. The cylindrical spool or spools may be used to wind a power cord. The ratchet may intermittently prevent the cord from retracting as it is deployed from the device (e.g., by manually pulling upon the cord). The sliding electrical contacts may create and maintain electrical connection between the electrical terminations of the power cord that are fixed on the rotating spool, and corresponding electrical terminals that are fixed on the device or a second spool. For example, the sliding electrical contacts may slide over the fixed electrical terminals to maintain electrical communication.

However, Applicants have recognized that existing cord and cable retracting mechanisms often have a number of problems. For example, it is often possible for ratchet mechanisms to be in a state that prevents retraction of the power cord when the power cord is pulled to its maximum extent. This may be due to the cord being extended at an unknown distance from the spool. Furthermore, it is possible for the power cord to become jammed as it is retracted onto the spool due to "bunching" of the cord on the spool. This bunching may happen due to lack of control of the position of the cord along the length of the spool. It is also possible for the sliding electrical contacts to lose electrical conductivity due to oxidation, accumulation of dirt, wear, etc. Reduced conductivity can result in generation of heat, or failure of the retracting mechanism to provide electrical power to a load.

The present disclosure presents a plurality of cable retractors and retraction mechanisms. The disclosed embodiments may provide improved operation with respect to one or more of the above problems, and/or provide other benefits. In one embodiment, a cable retractor includes a plug and jack capable of carrying the required power. The plug and jack may be used to make the electrical connection from the rotating cord to a stationary hub. For example, a cord may extend from the plug and jack to a stationary location and the cord may accommodate rotation of a spool by flexing or twisting. In one embodiment, the plug and jack each include three contacts to accommodate ground, power, and neutral wires. In one embodiment, a cable retractor may include a spool or hub that has a spiral channel extending around the spool or hub and into which the cable is automatically guided as it is wound onto the hub. For example, the channel may include grooves and ridges similar to a screw thread. The grooves and ridges may be sized to accommodate the power cord, or at least a portion of the power cord.

A detailed description of systems and methods consistent with embodiments of the present disclosure is provided below. While several embodiments are described, it should be understood that disclosure is not limited to any one embodiment, but instead encompasses numerous alternatives, modifications, and equivalents. In addition, while numerous specific details are set forth in the following description in order to provide a thorough understanding of the embodiments disclosed herein, some embodiments can be practiced without some or all of these details. Moreover, for the purpose of clarity, certain technical material that is known in the related art has not been described in detail in order to avoid unnecessarily obscuring the disclosure.

Turning to the figures, FIG. **1** illustrates a medical device trolley **100** with one embodiment of a cable retractor **102**. The trolley **100** may include a port or station for one or more electrical devices, such as a patient monitor. The trolley **100** may also include an electrical outlet for plugging in other devices. The cable retractor **102** may include a cable to selectively connect the trolley **100** to a wall outlet and power any connected devices, recharge a battery, or the like. In one embodiment, the cable retractor **102** allows a cord or cable to selectively extend for connection to a power outlet and retract for transportation. The cable retractor **102** may provide power to the trolley **100** and/or any electrical devices on or plugged into the trolley **100**. The cable retractor **102** may be integrated with the trolley **100** or may be mounted on a mounting structure of the trolley **100**. The trolley **100** is only one example of a device on which a cable retractor **102** is mounted. For example, the cable retractor **102** may be sized for or mounted on any type of device or structure that may selectively use electrical power.

FIGS. **2-6** illustrate various views of one embodiment of a cable retractor **102**. FIG. **2** is a close-up view of the cable retractor **102** with an exterior housing or casing removed. The cable retractor **102** includes a structural bracket **202** or other support member that provides mechanical support for the assembly and attaches the cable retractor **102** to the trolley **100**. The bracket **202** provides a support structure for mounting and/or supporting other elements of the cable retractor **102**. In one embodiment, the bracket **202** includes attachment mechanisms or features (e.g., holes or a corresponding shape) to secure the cable retractor **102** to the trolley **100** or other electrical device.

The cable retractor **102** includes a spool **204** rotatably mounted on the bracket **202**. For example, the spool **204** may be mounted on an axle (see FIGS. **3-6**), one or more bearings (see FIG. **4**), or the like to allow the spool **204** to rotate with respect to the bracket **202** and/or one or more other components of the cable retractor **102**. A power spring **206** provides a torsional force to the spool **204** in a rotational direction to bias the spool **204** toward a wound or retracted position. The power spring **206** is given by example only and may be replaced with any other type of spring or biasing member to rotationally bias the spool **204** toward a wound position or in a retracting rotational direction.

A retractable cable **208** is shown wound around the spool **204**. The spool **204** includes a groove or channel around an outside surface to accommodate the retractable cable **208**. In FIG. **2**, the groove or channel (see, e.g., FIG. **4**) is obscured by the retractable cable **208** which is wound around the spool **204** following the channel. The retractable cable **208** includes a flexible electrical cable that allows the retractable cable **208** to be selectively extended and retracted onto the spool **204**. The retractable cable **208** includes a plug connector **210** at an end extending from the spool **204** that is configured to couple to an electrical outlet. For example, the retractable cable **208** may be extended to couple a plug **210** to a wall outlet to provide power to the trolley **100** or another attached device or system. Similarly, the retractable cable **208** may be retracted to a fully retracted position (as shown) for storage of the retractable cable **208** during transport.

The cable retractor **102** also includes a dispensing guide **212** that causes the retractable cable **208** to extend from the spool **204** at a specific location and/or angle. The dispensing guide **212**, along with the groove or channel of the spool **204**, causes an amount of retractable cable **208** extending from the spool **204** to be determined based on a rotational position of the spool **204**. For example, given a specific rotational position of the spool **204**, it may be precisely known or determined how much of the retractable cable **208** extends from the spool **204** or remains wound on the spool **204**. The dispensing guide **212** includes a hole or grommet that has a fixed position in relation to the bracket **202** and thus predetermines an angle or angular location at which the retractable cable **208** extends from the spool **204**.

FIG. **3** shows the cable retractor **102** of FIG. **2** with the bracket **202**, spool **204**, power spring **206**, and dispensing guide **212** removed to illustrate other components of the cable retractor **102**. The retractable cable **208** is shown in a wound helical position as shown in FIG. **2**. Near a first end **302** of the cable retractor **102**, the retractable cable **208** is connected to a plug connector **210**. Near a second end **304** of the cable retractor **102**, the retractable cable **208** extends toward a region interior[GJ1] to the helix formed by the retractable cable **208** to connect with an interior cable **306**. Electrical connectors (obscured by the retractable cable **208**) are used to connect the retractable cable **208** with the interior cable **306**. The interior cable **306** extends from the electrical connectors and is wound, interior to the helix formed by the retractable cable **208**, from the first end **302** to the second end **304**. Near the second end **304**, the interior cable **306** connects to an electrical junction **308** where electrical power is provided to an outlet **310** and to an input **312** to the trolley **100**, or other device.

The outlet **310** may be used to electrically connect to an electrical device such that the retractable cable **208** and the interior cable **306** provide electrical power to a device via the outlet **310**. Thus, electrical connection from the retractable cable **208** to a device is achieved via the interior cable **306**. According to one embodiment, one end or portion of the interior cable **306** is fixed relative to the spool **204** (and an external cable such as the retractable cable **208**) while the another end or portion of the interior cable **306** is fixed relative to a bracket **202** (see FIG. **2**). Thus, the different ends or portions of the interior cable **306** may move, rotate, and/or twist with respect to each other. In one embodiment, a first spool bracket **314** is used to attach the retractable cable **208** to the spool **204** and a second spool bracket **316** is used to attach a portion of the interior cable **306** to the spool **204** (not shown). A cable clamp, or other fastener, may be used to fasten another portion of the interior cable **306** to the bracket **202**. The electrical junction **308** of the interior cable **306** may also be fastened to the bracket **202** using screws (not shown).

Also shown in FIG. **3** are an axle **318** and guide disks **320**. Some of the guide disks **320** are obscured by the retractable cable **208**. The spool **204** may be mounted on the axle **318**. In one embodiment, the axle **318** may be mounted on bearings and the spool **204** may be mounted on the axle **318** to rotate with the spool **204**. In one embodiment, the spool **204** may rotate independently of the axle **318**. The guide disks **320** are mounted on the axle **318** and guide the interior cable **306** from the first end **302** to the second end **304**. For example, the interior cable **306** may be routed around the axle **318** and between the guide disks **320** (see FIG. **4**). The guide disks **320** may guide flexion of the interior cable **306** within the spool **204** to prevent the interior cable **306** from winding or flexing excessively in any given region along the length of the spool **204**. For example, the guide disks **320** may keep the interior cable **306** from bunching when the retractable cable **208** is extended or retracted.

FIG. **4** illustrates an interior cable assembly **400** showing the winding or routing of the interior cable **306** around the axle **318** and through the guide disks **320**, according to one embodiment. The retractable cable **208** and some other components are excluded to avoid obscuring the interior cable **306** and other components of the interior cable assembly **400**. In the depicted embodiment, the interior cable assembly **400** includes six guide disks **320** and five alignment collars **402**. The interior cable assembly **400** also includes a plate **408** which may be used to support and/or fasten a spool **204** in relation to the axle **318**. The guide disks **320** have a disk shape forming part of a helix. For example, the guide disks **320** may not be flattened within a plane but may form a small section of a helix or screw. The interior cable **306** is wound between the guide disks **320**, forming a helix. The alignment collars **402**, or bushings, control spacing, relative rotation, and relative location of the guide disks **320**. For example, the alignment collars **402** may keep a specific spacing between the guide disks **320** and may limit rotation of the guide disks **320** in relation to each other. In one embodiment, stepped interfacing surfaces of the guide disks **320** and the alignment collars **402** constrain their relative rotational placement (see, for example, at location **404**). In one embodiment, the guide disks **320** are free to rotate within limits dictated by the stepped interfaces.

The interior cable **306** extends from the junction **308**, through the guide disks **320**, and around the axle **318** to an electrical connector **406**. The electrical connector **406** is configured to connect to an end of the retractable cable **208**. A corresponding connector may be on an end of the retractable cable **208**. In one embodiment, the electrical connector **406** is coupled to the retractable cable **208** at a rotating location. For example, the electrical connector **406** may rotate with the spool **204** as the retractable cable **208** is extended and retracted. In one embodiment, electrical conductors or contacts of the electrical connector **406** are substantially stationary with respect to a corresponding connector of the retract-

able cable **208**. For example, electrical conductors connecting the retractable cable **208** and the interior cable **306** may be substantially stationary with respect to each other during rotation of the spool **204**. For example, the connector of the retractable cable **208** and the connector **406** of the interior cable **406** may be connected such that the electrical conductors are not allowed to slide or rotate with respect to each other. In one embodiment, the electrical connector **406** may be one part of a plug/jack connector to couple the retractable cable **208** and the interior cable **306**. In one embodiment, conductors of the retractable cable **208** and the interior cable **306** may be welded or soldered together. In one embodiment, the interior cable **306** and the retractable cable **208** may be part of the same continuous electrical cable (e.g., having one or more continuous electrical conductors or wires).

In one embodiment, electrical conductors connecting the retractable cable **208** and the interior cable **306** (or other stationary conductor or location) may rotate and/or slide relative to each other. For example, a phono plug and jack connector, which is well-known in the art, may be used to provide electrical connection between the retractable cable **208** and the interior cable **306**. For example, the phono plug and jack may be connected to power cables instead of audio cables. The phono plug and jack may include electrical connectors that are commonly used in audio equipment and audio interconnections which are allowed to rotate relative to each other. In one embodiment, the phono plug and jack are positioned along an axis of rotation of the spool **204**. The phono plug and jack may rotate relative to each other and maintain electrical contact during rotation of the spool **204**.

The interior cable **306** extends between a rotating location (e.g., the connector **406** rotates with the spool **204**) and a stationary location (e.g., the junction **308** remains stationary). In one embodiment, the fixed location may include a port or connector to connect to a device and the rotating location may include a port or connector to connect to a retractable cable. Thus, the interior cable **306** accommodates movement of the spool **204** in relation to the bracket **202** by twisting, flexing, winding, and/or unwinding as the retractable cable **208** is extended or retracted. The interior cable **306** provides electrical communication between two locations that move relative to each other, without any sliding electrical contacts. Elimination of sliding electrical contacts can allow for greater longevity of the cable retractor **102** as well as reducing resistance between moving and stationary parts. In one embodiment, due to the length of the interior cable **306**, the strains on the interior cable **306** are minimal and allow for long life. Similarly, the interior cable **306** may include particularly flexible material and/or wires to reduce strain or breakage of electrical conductors.

In one embodiment, the interior cable **306** is pre-bent, pre-twisted, or pre-flexed to accommodate at least a portion of the rotation of the spool **204**. For example, the interior cable **306** may include a pre-bent or pre-twisted shape to reduce any strain experienced by the interior cable **306**. In one embodiment, the interior cable **306** is pre-bent so that the interior cable **306** experiences a neutral strain when the retractable cable **208** is halfway extended from or retracted on the spool **204**. This may reduce the total strain experienced by the interior cable **306** by one half. In one embodiment, the interior cable **306** may provide a biasing force to rotationally bias the spool **204** in a retracting direction. For example, a power spring **206** may not be needed because the biasing force may be provided by the interior cable **306**, which also serves the purpose of electrically coupling a retractable cable **208** to a device attached to the cable retractor **102**.

FIG. **5** illustrates a cross-sectional view of components of a cable retractor **102**, according to one embodiment. FIG. **5** illustrates the plate **408** that mechanically supports and fastens the spool **204** to the axle **318** or shaft. The axle **318** is mechanically supported and fastened to the bracket **202** by a first bearing **502** and by a second bearing **504**. The power spring **206** (or other spring) torsionally preloads the axle **318**. The power spring **206** is housed in a housing and is fastened to the bracket **202** via a power spring housing, sandwiching the first bearing **502** onto the bracket **202**. The power spring **206** also provides a restorative torsion on the axle **318** when the retractable cable **208** is deployed.

A cross-sectional shape of the spool **204** and grooves is also shown. The spool **204** includes ridges **506**, or raised portions, which form grooves in which the retractable cable **208** is positioned when the retractable cable **208** is on the spool **204**. In one embodiment, as the retractable cable **208** is selectively retracted the spool **204** rotates and the retractable cable **208** is guided into the helical groove between the ridges **506**. In one embodiment, the ridges **506** form a helical groove having a width corresponding to a cross-sectional width of the retractable cable **208**. In one embodiment, the ridges **506** (or a single ridge) form a helical groove that is continuously connected to and circumscribes the spool **204** a plurality of times. The ridges **506** and groove extend from a location proximal to first end **302** of the spool **204** to a location proximal to a second end **304** of the spool **204**. In one embodiment, the ridges **506** have a height sufficient to receive a cross-sectional width of the retractable cable **208**. Ridges **506** having a height equal to or greater than the cross-sectional width of the retractable cable **208** may more effectively guide the retractable cable **208** into the grooves than more shallow ridges.

FIG. **6** is a perspective side view of a cable retractor **102** illustrating a ratchet **602** and a pawl **604** for controlling retraction of the retractable cable **208**. The ratchet **602** is mounted and rotationally bound to the axle **318** and the spool **204**. The pawl **604** is stationary (e.g., mounted on the bracket **202**) but is able to pivot at pivot point **606**. A tension spring may bias the pawl **604** in default vertical alignment as shown in order to engage the ratchet **602**. In one embodiment, the tension spring is enclosed in a spring housing **608**.

The ratchet **602** includes a plurality of teeth **610**. The teeth **620** are spaced to form a plurality of small gaps **612** and a large gap **614**. When the spool **204** is at a rotational position such that the pawl **604** engages a small gap **612**, the pawl **604** restricts movement of the spool **204** in a retracting direction but still allows a user to further extend the retractable cable **208** by pulling the retractable cable **208** in an extending direction. When the spool **204** is at a rotational position such that the pawl **604** is positioned in the large gap **614**, the spool **204** may begin moving in a retracting direction and continue moving in that direction toward a retracted position. For example, as the axle **318** rotates, the ratchet **602** is intermittently prevented from retracting due to the point of the pawl **604** engaging with the teeth **610** of the ratchet **602**. When the pawl **604** coincides with the region of ratchet **602** without teeth **610** (e.g., the large gap **614**), the axle **318** and the spool **204** are free to rotate for retraction of the retractable cable **208** because the teeth **610** press against only a curved edge of the pawl **604**, which provides no substantial resistance.

In one embodiment, the large gap **614** corresponds to a rotational position where the retractable cable **208** is fully extended. For example, when the retractable cable **208** is fully extended, the ratchet **602** and the pawl **604** allow a biasing member to retract the retractable cable **208**. The large gap **614** may also correspond to a plurality of intermediate positions

such that the retractable cable **208** must not be fully extended in order to initiate retraction. Thus, the pawl **604** intermittently allows retraction of the retractable cable **208**. In one embodiment, the groove on the spool **204** causes a specific rotational position of the spool **204** to accurately correspond to a specific length of the retractable cable **208** that is on or off the spool **204**. In some embodiments, this ensures that the pawl **604** will be positioned in the large gap **614** when the retractable cable **208** is fully extended, which keeps the retractable cable **208** from getting stuck in an extended position.

Example operation of the cable retractor **102**, according to one embodiment, will now be explained. The cable retractor **102** may be operated by a user by pulling the plug connector **210** and thereby causing the spool **204** to spin and for the retractable cable **208** to be unwound from the spool **204**. The dispensing guide **212** ensures that the retractable cable **208** exits from the spool **204** at a known angular position. Similarly, the helical grooves on the spool **204** ensure that the spool **204** rotates a precise number of turns (e.g., eight turns of 360° in the embodiments of FIGS. **2-6**) from the beginning to the end of the deployment. As such, when the retractable cable **208** is fully deployed, the pawl **604** is positioned over the region of the ratchet **602** without teeth **610**, and therefore does not prevent the retractable cable **208** from being retracted by the force applied by the power spring **206**.

During deployment and retraction of the retractable cable **208**, the fastened end of the interior cable **306** rotates relative to a stationary end (e.g., up to eight turns in each direction). The guide disks **320**, in conjunction with the alignment collars **402**, constrain the interior cable **306** as this rotation occurs, and thereby maintain orderly constriction and expansion of the interior cable **306**. In particular, the guide disks **320** prevent the interior cable **306** from winding or unwinding excessively in any given region along the length of the axle **318** (i.e., shaft) or spool **204**.

It should be noted that in one embodiment, the interior cable **206** is pre-coiled through appropriate fabrication processes, as this may ease assembly somewhat. However, pre-coiling may not be essential to the proper function of the cable retractor **102**. It should also be noted that the system of guide disks **320** and alignment collars **402** may be indefinitely extended over any distance to permit more rotations of the spool **204** if this is desired to achieve a longer deployed retractable cable **208** length. Some limitation on the length of an axle **318** and/or the number of guide disks **320** or alignment collars **402** include potential degraded function due to increased friction, and greater space required. The number of guide disks **320** and alignment collars **402** may vary as needed over the length of the spool **204**. For example, fewer or more guide disks **320** may be included over the same length, in some embodiments.

By way of further detail, when the spool **204** rotates during deployment of the retractable cable **208**, the spool **204** may initially rotate freely with respect to the guide disks **320**, but after a predetermined amount of rotation a tooth or feature on the spool **204** may engage a tooth or protrusion on the adjacent guide disk **320** and subsequently causes it to rotate. After another predetermined amount of rotation, a far tooth on the guide disk **302** may engage a near tooth on an adjacent alignment collar **402**, causing it to rotate. After yet another predetermined amount of rotation, a far tooth on the adjacent alignment collar **402** engages a near tooth on the next guide disk **320**, and so on, all the way to the last guide disk **320**. When the spool **204** rotates during retraction of the retractable cable **208**, a similar sequence of events occurs, with the teeth or protrusions of the guide disks **320** and the alignment collars **402** engaging in series, causing an inverted sequence of rotations and interferences to occur.

In addition to the embodiments discussed above, several other embodiments are also contemplated within the scope of the present disclosure. According to one embodiment, the interior cable **306** is not pre-coiled. According to one embodiment, one or more cable supports may be provided in or on the interior cable **306**. For example, the cable supports may create a default position for the interior cable **306** to which the interior cable **306** returns after being flexed or twisted. Similarly, the cable supports may keep any portion of the interior cable **306** from being excessively twisted or bent during flexion of the interior cable **306**. For example, the cable supports may eliminate a need for guide disks **320** and/or alignment collars **402**. In one embodiment, the cable supports may serve to bias the interior cable **306**, and the spool **204**, toward a retracted position.

FIG. **7** is a perspective view of an interior cable **306** with an embedded cable support **702**. The embedded cable support **702** is represented by a broken line and runs through the interior of the interior cable **306**. For example, the embedded cable support **702** may include an appropriate metal wire down a center of the interior cable **306**. The embedded cable support **702** may cause the interior cable **306** to constrict and expand in a deterministic manner, for example, like a helical spring.

In one embodiment, the embedded cable support **702** may cause the interior cable **306** to have a pre-bent or pre-twisted shape. In one embodiment, the pre-bent or pre-twisted shape corresponds to a number of bends or twists in the interior cable **306** when the retractable cable **208** is extended about halfway between a fully retracted state and a fully extended state. In one embodiment, the embedded cable support **702** (or other flexible support structures) may control flexion of the interior cable **306** during rotation of the spool **204**.

In one embodiment, a cable support may be used, similar to the embedded cable support **702** described above, except the cable support may be attached to an exterior of the interior cable **306**. For example, a metal wire may be attached on an exterior$_{[GJ2]}$ of the interior cable **306** using shrink tubing or the like such that the interior$_{[GJ3]}$ cable **306** constricts and expands in a deterministic manner, like a helical spring, without the need for the guide disks **320** and the alignment collars **402**. In one embodiment, a cable jacket of the interior cable **306** may include non-standard materials that increase rigidity, while still being flexible, to cause the interior cable **306** to constrict and expand in a deterministic manner. In one embodiment, the interior cable **306** has a modified or reinforced cable jacket to provide more rigidity, and/or may include a greater length such that there are more coils. In one embodiment, the interior cable **306** constricts in a slightly chaotic manner, due to uncontrolled interference of the interior cable **306** along the axis of the axle **318**, yet without the need of the guide disks **320** and the alignment collars **402** to reliably achieve the required number of rotations, and to reliably return to a known default shape.

FIG. **8** illustrates one embodiment of an interior cable **306** that includes one or more separate wire sections **802**. In one embodiment, the separate wire sections **802** are positioned on a rotational axis of the spool **204**. For example, the axle **318** may be omitted so that the separate wire sections **802** may be positioned on the rotational axis. The separate wire sections **802** extend between a first anchor **804** positioned near one end of the spool **204** and a second anchor **806** positioned near an opposite end of the spool **204**. The anchors **804**, **806** may include holes **810** or other features to mount the anchors **804**, **806** to a fixed or rotating location. In one embodiment, the

first anchor **804** remains stationary and the second anchor **806** rotates with spool **204**. For example, when the spool **204** rotates, the separate wire sections **802** of the interior cable **306** twist about each other in a helical manner (or untwist).

In the depicted embodiment, the separate wire sections **802** include wires without a common cable jacket. For example, wire conductors of the interior cable **306** may be within a cable jacket at a first end **812** and a second end **814** of the interior cable **306** but may be separate wires (with insulating shielding) between the anchors **804**, **806**. It should be understood that the separate wire sections **802** may only be straight (or approximately straight) at one point of the rotation of the spool **204**. In one embodiment, the separate wire sections **802** may be a little longer than needed to reduce strain during rotation of the spool **204**. In one embodiment, the separate wire sections **802** are approximately straight when the retractable cable **208** is halfway extended. For example, a default state of the separate wire sections **802** may be such that an anchor **804** is rotated half the number of total spool **204** rotations required to fully extend a retractable cable **208**. This may cause the separate wire sections **802** to unwind as a retractable cable **208** is pulled from a fully retracted state to a halfway extended state and to wind around each other as the retractable cable **208** is pulled from the halfway extended state to a fully extended state. The winding/unwinding may happen in reverse as the retractable cable **208** is retracted. This pre-wound state may reduce the maximum torsional stress more than[GJ4] if the separate wire sections **802** are required to wind (or unwind) between a fully retracted and a fully extended rotational position of the spool **204**. In one embodiment, the separate wire sections **802** have strain reliefs **808** where they are fastened to the anchors **804**, **806** to reduce bending stresses near the anchors **804**, **806** and increase the life of the separate wire sections **802**. The strain reliefs **808** may reduce a degree of flexion of the one or more second lengths of electrical cables proximal to one or more of the first location and the second location.[GJ5]

In one embodiment, the first anchor **804** and second anchor **806** may be mounted such that they can slide along the axis, so that they can move toward each other to reduce stress as the wires are twisted and/or move outward as the wires are untwisted. Furthermore, one or more springs may be used to preload or bias the anchors **804**, **806** away from each other. In one embodiment, a compression spring may extend between the anchors **804**, **806** to provide a force to push the anchors **804**, **806** away from each other to restore them to their original positions as the wires are untwisted. In one embodiment, separate compression springs or tension springs may be used to independently push or pull the anchors **804**, **806** away from each other. For example, a first tension spring may extend between the first anchor **804** and stationary location (or location that doesn't slide along an axis of rotation) to pull the first anchor away from the second anchor **806**. Similarly, an additional tension or compression spring may be used to bias the second anchor **806** away from the first anchor **804**.

In the embodiments discussed above, the interior cable **306** occupies a large portion of a length of the spool **204**. For example, the greater the length of the interior cable **306**, the lower the stress the interior cable **306** may experience as the spool **204** rotates. In one embodiment, the interior cable **306** may be wound in a more two-dimensional shape to limit a longitudinal space (space in a direction of an axis of the spool **204**) occupied by the interior cable **306**. For example, the interior cable **306** may be wound in an Archimedean spiral such that ends of the interior cable **306** are at an outer edge of the spiral and a halfway point of the interior cable **306** is located at the center of the Archimedean spiral.

Although the present disclosure focuses on cable retractors for power cables, it should be understood that cable or cord retractors for any type of cable or cord are contemplated. For example, cable retractors for retracting hoses that carry liquid or air may employ many of the teachings provided herein.

EXAMPLES

The following examples pertain to further embodiments.

Example 1 is a cord retractor mechanism that includes a support member (e.g., a bracket **202**), a first length of electrical cord, a spool, and a second length of electrical cord. The spool includes a helical groove on an outer surface of the spool. The helical groove has a width corresponding to a cross-sectional width of the first length of electrical cord and the spool is rotatably mounted on the support member. The second length of electrical cord is electrically coupled to the first length of electrical cord. A first portion of the second length of electrical cord is secured at a rotating location and a second portion of the second length of electrical cord is secured at a stationary location, wherein the rotating location moves with the spool and the stationary location remains stationary with respect to the support member. The first length of electrical cord is selectively extendable from and retractable on the spool and the second length of electrical cord flexes to accommodate the movement of the rotating location with respect to the stationary location while maintaining electrical communication between the rotating location and the stationary location. When the first length of electrical cord is selectively retracted the spool rotates and the first length of electrical cord is guided into the helical groove on the spool.

Example 2 is a cord retractor mechanism that includes an electrical cord, a rotatably mounted spool, a grommet, a bias mechanism, a ratchet, and a pawl. The rotatably mounted spool includes a helical groove on an outer surface of the spool. The helical groove is a continuously connected groove circumscribing the spool a plurality of times and extending from a location proximal to a first end of the spool to a location proximal to a second end of the spool. The helical groove has a width corresponding to a cross-sectional width of the electrical cord. The grommet guides the electrical cord to extend from the spool at a known or specific angular location. The bias mechanism biases the spool in a retracting rotational direction. The ratchet is mounted to rotate with the rotatably mounted spool and includes a plurality of teeth. A gap between the teeth at a rotational position corresponding to the electrical cord being fully extended from the spool has a larger size than gaps corresponding to other rotational positions. The pawl is configured to engage the teeth of the ratchet to intermittently prevent rotation of the spool in the retracting rotational direction.

Example 3 is a device that includes a rotatably mounted spool, a first length of electrical cable, and one or more second lengths of electrical cables. The first length of electrical cable is flexible to selectively wind around or unwind from the spool. The one or more second lengths of electrical cables extend between a first port to connect with the first length of electrical cable and a second port to connect with an electrical device at a second location. The one or more second lengths of electrical cables extend between a first location and a second location. The first location is a location that rotates with the spool, and the second location is stationary such that the first location rotates relative to the second location. When the spool rotates, the one or more second lengths of electrical cables flex to accommodate the movement of the first location

with respect to the second location while maintaining electrical communication between the first location and the second location.

Reference throughout this specification to an "example" or an "embodiment" means that a particular feature, structure, or characteristic described in connection with the example is included in at least one embodiment of the present invention. Thus, appearances of the phrase "for example" or "in one embodiment" in various places throughout this specification are not necessarily all referring to the same embodiment.

As used herein, a plurality of items, structural elements, compositional elements, and/or materials may be presented in a common list for convenience. However, these lists should be construed as though each member of the list is individually identified as a separate and unique member. Thus, no individual member of such list should be construed as a de facto equivalent of any other member of the same list solely based on its presentation in a common group without indications to the contrary. In addition, various embodiments and examples of the present invention may be referred to herein along with alternatives for the various components thereof. It is understood that such embodiments, examples, and alternatives are not to be construed as de facto equivalents of one another, but are to be considered as separate and autonomous representations of the present invention.

It will be obvious to those having skill in the art that many changes may be made to the details of the above-described embodiments without departing from the underlying principles of the invention. The scope of the present invention should, therefore, be determined only by the following claims.

The invention claimed is:

1. A cord retractor comprising:

a support member;

a first length of electrical cord;

a spool comprising a helical groove on an outer surface of the spool, wherein the helical groove comprises a width corresponding to a cross-sectional width of the first length of electrical cord, wherein the spool is rotatably mounted on the support member; and

a second length of electrical cord electrically coupled to the first length of electrical cord and helically extending within, radially separated from, and co-axially relative to the spool, wherein a first portion of the second length of electrical cord is secured at a rotating location and a second portion of the second length of electrical cord is secured at a stationary location, wherein the rotating location moves with the spool and the stationary location remains stationary with respect to the support member;

wherein the first length of electrical cord is selectively extendable from and retractable on the spool and wherein the second length of electrical cord flexes to accommodate the movement of the rotating location with respect to the stationary location while maintaining electrical communication between the rotating location and the stationary location, and wherein when the first length of electrical cord is selectively retracted the spool rotates and the first length of electrical cord is guided into the helical groove.

2. The cord retractor of claim **1**, wherein the helical groove comprises a continuously connected groove circumscribing the spool a plurality of times and extending from a location proximal to first end of the spool to a location proximal to a second end of the spool.

3. The cord retractor of claim **2**, further comprising a dispensing guide comprising an opening to cause the first length of electrical cord to extend from the spool at a predetermined angle in relation to the spool, wherein an amount of the first length of electrical cord wound on the spool in the helical groove is determined based on the rotational position of the spool.

4. The cord retractor of claim **1**, wherein the support member comprises an attachment mechanism to secure the cord retractor to an electrical device.

5. The cord retractor of claim **1**, further comprising one or more bearings supporting the spool in relation to the support member.

6. The cord retractor of claim **1**, wherein the second length of electrical cord comprises a pre-bent or pre-twisted shape to accommodate flexion during rotation of the spool.

7. The cord retractor of claim **6**, wherein the pre-bent or pre-twisted shape comprises a pre-bent or pre-twisted shape corresponding to a number of bends or twists in the first length of electrical cord when the first length of electrical cord is extended about halfway between a fully retracted state and a fully extended state.

8. The cord retractor of claim **6**, wherein the second length of electrical cord comprises one or more flexible support structures to control flexion of the second length of electrical cord during rotation of the spool.

9. The cord retractor of claim **1**, further comprising a biasing member configured to rotationally bias the spool in a retracting direction.

10. The cord retractor of claim **1**, wherein the second length of electrical cord provides a biasing force to rotationally bias the spool in a retracting direction.

11. The cord retractor of claim **1**, further comprising a ratchet rotating with the rotatably mounted spool and comprising a plurality of teeth, wherein a gap between the teeth at a rotational position corresponding to the first length of electrical cord being fully extended from the spool comprises a larger size than gaps corresponding to other rotational positions.

12. The cord retractor of claim **11**, further comprising a pawl rotatably fixed to the support member and configured to engage the teeth to selectively limit rotation of the spool in a retracting direction, wherein when the pawl is positioned in the gap between the teeth at the rotational position corresponding to the first length of electrical cord being fully extended, the pawl allows the ratchet and spool to rotate in the retracting direction.

13. A cord retractor comprising:

an electrical cord;

a rotatably mounted spool comprising a helical groove on an outer surface of the spool, the helical groove comprising a continuously connected groove circumscribing the spool a plurality of times and extending from a location proximal to a first end of the spool to a location proximal to a second end of the spool, and wherein the helical groove comprises a width corresponding to a cross-sectional width of the electrical cord;

a grommet configured to guide the electrical cord to extend from the spool at a known angular location;

a bias mechanism to bias the spool in a retracting rotational direction;

a ratchet rotating with the rotatably mounted spool comprising a plurality of teeth, wherein a gap between the teeth at a rotational position corresponding to the electrical cord being fully extended from the spool comprises a larger size than gaps corresponding to other rotational positions; and

a pawl configured to engage the teeth of the ratchet to intermittently prevent rotation of the spool in the retracting rotational direction.

14. The cord retractor of claim 13, wherein the electrical cord comprises a plug connector at an end extending from the spool, wherein the plug connector is configured to couple to an electrical outlet.

15. The cord retractor of claim 14, further comprising an outlet port configured to electrically connect the cord retractor to an electrical device, wherein the electrical cord is configured to provide electrical energy from an outlet to the outlet port.

16. The cord retractor of claim 13, further comprising a plug and jack to provide electrical connection between the electrical cord and a stationary location, wherein the plug and jack are positioned along an axis of rotation of the spool and wherein the plug and jack rotate relative to each other and maintain electrical contact during rotation of the spool.

17. A device comprising:

a rotatably mounted spool;

a first length of electrical cable, wherein the first length of electrical cable is flexible to selectively wind around or unwind from the spool; and

one or more second lengths of electrical cables helically extending within, radially separated from, and co-axially relative to the spool and between the first length of electrical cable and a port to connect with an electrical device

wherein the one or more second lengths of electrical cables extend between a first location and a second location, wherein the first location comprises a location that rotates with the spool and the second location is stationary such that the first location rotates relative to the second location and wherein when the spool rotates the one or more lengths of second lengths of electrical cables flex to accommodate the movement of the first location with respect to the second location while maintaining electrical communication between the first location and the second location.

18. The device of claim 17, wherein, at at least one rotational position of the spool, the one or more second lengths of electrical cables are bent or twisted in a shape comprising one or more of:

an Archimedean spiral;

a helix; and

a substantially straight section.

19. The device of claim 17, further comprising one or more strain reliefs configured to reduce a degree of flexion of the one or more second lengths of electrical cables proximal to one or more of the first location and the second location.

20. The device of claim 17, further comprising an axle, wherein the spool is mounted on the axle.

21. The device of claim 20, further comprising one or more guide disks mounted on the axle and within the spool, wherein the one or more second lengths of electrical cables are routed around the axle and between the guide disks, and wherein the guide disks guide flexion of the one or more second lengths of electrical cables within the spool to prevent the one or more second lengths of electrical cables from winding or unwinding excessively in any given region along the length of the spool.

22. The device of claim 21, further comprising one or more alignment collars configured to constrain relative location and placement of the one or more guide disks.

23. The device of claim 17, wherein electrical contacts connecting the first length of electrical cable and the one or more second lengths of electrical cables are substantially stationary with respect to each other during rotation of the spool.

24. The device of claim 23, wherein the first length of electrical cable and the one or more second lengths of electrical cables are connected such that the electrical contacts are not allowed to slide or rotate with respect to each other.

25. The device of claim 23, further comprising a plug and jack comprising the electrical contacts.

26. The device of claim 17, wherein the first length of electrical cable and the one or more second lengths of electrical cables are one of:

part of a single continuous electrical cable; and

are electrically connected via electrical contacts soldered or welded together at the first location.

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